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for a new and useful invention entitled:

VALVE ASSEMBLY AND METHOD

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VALVE ASSEMBLY AND METHOD

FIELD OF THE INVENTION

[0001] The present invention relates generally to valve assemblies and methods for making such assemblies.

BACKGROUND OF THE INVENTION

[0002] Valve assemblies, including check valves, are used in a wide variety of industries for an extensive range of applications. In many applications, hydraulic valves are required to meet certain weight and space, or "envelope," constraints in view of high flow rates and high operating pressures. In view of weight and space restrictions, check valve manufacturers are commonly forced to utilize single piece housings for the body, which commonly restrict the size of the internal components to the size of the associated coupling or adapter inlet/outlet ports through which they must pass.

[0003] A common performance characteristic associated with check valves is the degree of pressure drop. Users typically want to have the lowest pressure drop that is reasonably attainable. However, the obtainable pressure drop is inversely proportional to the reduction of the flow path cross sectional area through the valve housing. Factors that contribute to the pressure drop of hydraulic or pneumatic fluid conveyance devices include: a) fluid drag along the walls and surfaces; b) changes in direction of flow; c) the division of flow paths (such as the division of a single flow into several flow paths and corresponding merging of such flow paths back into a single path); d) acceleration and deceleration of the flow stream; and e) the formation and presence of eddy currents or non-laminar flow.

[0004] It is generally desirable to provide a valve with less (or reduced) pressure drop and lower assembly cost, while providing a reduced envelope and weight as compared to traditional valves. Two-piece valve housings with a large flow path may offer a corresponding low pressure drop, but often at the sacrifice of additional weight and size, assembly requirements, and cost. A balancing of factors and features is commonly necessitated. The present invention is developed in light of these and other considerations.

BRIEF SUMMARY OF THE INVENTION

[0005] Among other things, the present invention discloses a valve assembly that includes a body, a valve, a biasing mechanism, and a guide. The body includes a shaped cavity and the valve includes an elongated portion and a shaped valve head that has an exterior surface portion that is configured to engage a portion of the shaped cavity. The guide includes a central axis and a centrally disposed opening that receives a portion of the valve and guides the movement of the valve through at least a segment of the valve's axial motion. The biasing mechanism may include a spring that selectively biases the valve head in the direction of the shaped cavity. The invention further includes a method for making a valve assembly.

[0006] Other aspects of the invention will be apparent to those skilled in the art after reviewing the drawings and the detailed description below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

[0008] **Figure 1** is a partial cross sectional view of an embodiment of a valve assembly shown in a generally "open" configuration.

[0009] **Figure 2** is a partial cross sectional view of an embodiment of a valve assembly of the type depicted in Figure 1, generally shown in a "closed" configuration.

[0010] **Figure 3** is a cross sectional view of an embodiment of a valve guide.

[0011] **Figure 4** is front view of a valve guide of the type shown in Figure 3.

DETAILED DESCRIPTION OF THE INVENTION

[0012] Figure 1 illustrates a cross sectional view of a valve assembly 10 shown in accordance with an embodiment of the invention. The valve assembly 10 is shown in a generally "open" flow configuration and includes a body 12, a valve 14, and a guide 16. The body 12 includes a central longitudinal axis **L**, a fluid entry portion 20, a fluid outlet portion 22, and an

expanded cavity 24 with a shaped portion. In an embodiment of the invention, the shaped portion of the cavity 24 is in the form of a modified ellipsoid. The assembly 10 may take the form of a check valve and, for many applications, the body 12 can be comprised of an integral, single-piece housing. Moreover, if desired, the assembly 10 can be a configured for use as a standard coupling or adapter that may be configured to be mated with male-to-male or male-to-female fittings, including, without limitation, industry standard end fittings. The assembly of the present invention is not limited to a specific size and can cover a wide range of both conventional and unconventional sizes.

[0013] The valve 14 includes a valve head 26 and an elongated portion 28. In some embodiments, the ends of the spring engage an edge of the valve on one side and an edge of the guide on the other. The elongated portion 28 may include a stem portion 29 that has a reduced diameter compared to the segment of the elongated portion nearer the valve head 26. For embodiments that include such a stem portion 29, it is preferred that the elongated portion 28 and the stem portion 29 of the valve 14 engage two separate radially spaced segments of the guide 16 having different diameters. Such a configuration can, among other things, serve to: maintain a truer linear axial travel of the valve 16 through a stroke; maintain more accurate positioning of the valve at the body's valve seat; better support or guide a biasing mechanism (as discussed in further detail below); and/or, in the case of a biasing mechanism comprised of a spring 34, help prevent the compression of the spring coils from overlapping during valve travel or during assembly.

[0014] In an embodiment of the invention, the valve head 26 includes a shaped portion having a modified ellipsoid form (viewed from a side cross sectional view such as shown in Figure 1). The shaped portion of the cavity can be configured so that the cross sectional flow area past the valve head and through the valve is more consistent. As such, the shaped portion of the valve head 26 may have a surface that is a combination of several tangent radii. For instance, the surface may be comprised of four, five, or more radii with tangents (viewed in cross section) that work together to form a continuous surface. The specific radii associated with the shaped portion can be run through physical and analytic analysis and testing to determine specific configurations that are more conducive to improved valve operation, for example, a more consistent flow area through the assembly, reduced eddies, and more consistent cross sectional flow. As generally illustrated, the valve head 26 includes an exterior surface segment or portion

30 that substantially matches up with a similarly shaped portion of the cavity 24 of the body 12 at least at one point (or segment) of contact. Moreover, if desired, or if necessary for a given application, the external surface of the valve head 26 and corresponding and contacting surface portion of the cavity 24 can be tightly toleranced to prevent leakage.

[0015] Together, the valve head 26 and the cavity 24 form a flow passage through which a fluid may pass through the assembly 10. The associated guide 16 can serve several functions. Among other things, the guide 16 can (i) set or guide the travel of the valve 14 through all or a portion of its travel within the body 12, (ii) serve to stop and position the valve 14 at the full open position, and (iii) house or support a mechanism that positions the valve. Guide 16 preferably includes a front portion, which is a segment of the guide that is located in closer proximity to the valve head 26; a rear portion, which is a segment of the guide located in closer proximity to the fluid outlet portion 22; and an opening 32 with a central axis **CA** that receives and guides a portion of the valve 14. In an embodiment, the guide opening 32 receives and supports the elongated portion 28 of the valve and that portion 28 is permitted to move in a substantially linear axial manner along an adjacent length of the opening 32.

[0016] The valve assembly 10 may optionally include a mechanism that biases (and may selectively bias) the valve head 26 toward a forward position relative to the fluid entry portion 20. In the illustrated embodiment, the biasing mechanism includes a spring 34 that may provide a sufficient force, absent other external forces (including the flow of fluid), to generally urge a portion of the surface 30 of the valve head 26 against the interior wall of the cavity 24 to close the fluid passage formed between the cavity 24 and the head 26. For proper closure, the surface of the valve head and the surface of the cavity should be substantially tangent to one another at the point (or segment) of contact.

[0017] Figure 2 illustrates a valve assembly, such as that shown in Figure 1, which is shown in a substantially "closed" configuration. The present invention permits the biasing mechanism (e.g., spring 34) to be located outside of the fluid flow path, which, *inter alia*, eliminates the mechanism from causing a further obstruction to the flow and can provide better durability and reliability, for example, by reducing the corrosive effect to fluid on the biasing mechanism. In a preferred embodiment in which a spring 34 is the biasing mechanism, the spring 34 can be sufficiently constrained between two surfaces (e.g., the surfaces of the valve and the

guide) so that the spring cannot overlap or otherwise significantly depart from its intended path of movement.

[0018] If desired, the guide 16 may be configured to provide a dampening effect. That is, the variable volume cavity in which the biasing mechanism, such as a spring 34, is located generates a hydraulic dampening effect in connection with normal valve 14 opening and closing. The clearance between the associated mating surfaces (i.e., stem diameter of the valve 14 and the corresponding aperture diameter in the valve guide 16) can be tightly or more closely toleranced to control the amount of dampening, for instance by frictional engagement between components. Controlling the amount of dampening, among other things, can: adjust and control the speed of the valve during opening and closing, decrease the valve's impact energy with the seat in the body and the valve guide, and tend to increase the useful life of the components.

[0019] Figures 3 and 4 illustrate a side cross sectional and a rear view of a guide 16 shown in accordance with an embodiment of the invention. Guide 16 preferably includes at least one guide leg 36 and may additionally include a connection element 38 that connects the guide 16 to a portion of the body 12 and/or serves to help prevent axial travel of the guide 16 relative to the body. As described further herein, the connection element 38 may be spring-loaded or biased radially outwardly to provide a more secure fit with the body 12. Moreover, the guide 16 may be manufactured from a number of materials, provided the necessary strength, durability, and functionality are maintained. In a particular embodiment, the guide 16 is comprised of a tempered steel alloy. The guide leg 36 may include longitudinally or axially spaced segments (e.g., a front segment and a rear segment), or, for some embodiments, the guide leg 36 may run substantially the entire length of the guide 16. Additionally, in some embodiments, a portion of the guide leg may be spaced from the main body of the guide and may be cantilevered or configured to taper slightly outwardly (taken in the direction of the intended fluid flow) in its normal unassembled condition and provide a fairly consistent spring pre-load radially outward into the body 12. In that regard, the guide leg 36 can be configured to provide a measure of deflection, which can range, for example, from 0.005 to 0.032 inches, and can help to interconnect the guide 16 within the body 12 and retain it in a desired position while still permitting a fluid to flow past the guide 16 through the assembly 10. In some embodiments the fit of the guide should be relative close or sufficiently snug to avoid undesired movement or

rattle. In addition to the inclusion of a connection element 38, the shape of the leg 36 and amount of taper can be configured to optimize the wedging or "fit" of the guide 16 within the body 12.

[0020] While the invention is not limited to the embodiments illustrated in the drawing figures, some mention of the optional characteristics associated with an exemplary guide 16 and associated guide legs 36, such as illustrated in Figure 3, may be beneficial. Each of the legs 36 may include a fixed front centering portion or member (e.g., element 39a) and a fixed rear centering portion or member (e.g., element 39b). One or more of the legs 36 may include an intermediate, flexible, cantilevered, spring-loaded leg 36 and may further include an integral locking member (e.g., connection element 38). It is noted that the assembly 10 can include various combinations of one or more such members 39a, 39b, or 38. However, for purposes of illustration only, three front and rear centering formations are included, each of which may (or may not) include a connection element 38.

[0021] Continuing with the exemplary embodiment, the rear centering formations 39b preferably engage the inside wall of the body 12 and position and align the center of the valve guide 16 with the center of the body 12 at or adjacent to the fluid outlet portion 22. The front centering formation 39a engages the inside wall of the body 12 at or adjacent a throat area 41 to position and align the center of the valve guide 16 with the center of the body 12 at or about the throat area. Preferably, the front and rear centering formations 39a, 39b are positioned (often as far as possible from each other) to provide sufficient longitudinal stability. The combination of the front centering formations 39a in-concert with the rear centering formations 39b align, position and maintain the center-line of valve guides opening 32 with the center-line axis of the body 12. The plurality of contact points offset some distance apart along the length of the guide 16 helps to ensure that the linear travel of the valve 14 is in proper central longitudinal alignment with the body 12, which typically improves the tightness of the seal associated with the assembly.

[0022] In an embodiment of the invention, the body 12 may include formations, such as longitudinally extending grooves that, for example, may receive fin-like segments of the guide legs 36. The body 12 may additionally include one or more recesses or cavities, such as receiving element 40, which receive and help retain a portion of the guide leg 36 (which may include the connection element 38) at a desired position along the axial length of the assembly. In addition to centering the guide 16 within the cavity (and prohibiting rotation thereof), the

grooves can also serve to facilitate the interconnection of the connection elements 38 with corresponding receiving elements 40.

[0023] Retaining formations can typically be located anywhere in the body wall where they do not create an unacceptable stress concentration point which could generate a future fatigue structural failure mode. In some preferred embodiments, the grooves, recesses, or other attachment formations associated with the guide 16 are positioned beneath a shoulder of an associated fitting. For example, without limitation, such retention formations may be located within the external shoulder of a flare-less female fitting. Such a configuration can provide a measure of strength and reinforcement, help reduce the amount of stress on the body 12, and increase fatigue life. It is noted, however, that the guide 16 is not limited to a configuration with a single guide leg 36. Rather, the guide preferably includes a plurality of guide legs having various forms, including, for example, a guide 16 with three guide legs 36 as shown in Figure 4. With such an exemplary three-legged embodiment, the guide legs 36 may, by way of example and without limitation, take the form of relatively thin (e.g., less than 0.1 inch) support structures that extend the majority of the longitudinal length of the guide 16 and are circumferentially spaced apart (e.g., approximately 120 degrees from each another).

[0024] It is noted that the present invention can provide a significant increase in the cross sectional area of the flow path by moving the guide function, stop function and spring (or other mechanism for biasing the valve) from the radial area adjacent the inside walls of the body housing to substantially the centerline of the valve assembly. Moreover, the transitions of flow are also commonly improved with such a configuration, for example, by providing a relatively consistent fluid velocity and reducing the number of acceleration and decelerations in the fluid flow path.

[0025] In an embodiment, the body 12 includes a formation that receives a portion of the connection element 38 to at least partially secure the guide 16 within a segment of the body 12. Figures 1 and 2 generally illustrate an embodiment wherein the body 12, includes a receiving formation 40, in this case a groove or recessed portion, which receives a portion of the connection element 38 of the guide 16. In one particular embodiment, a gap 42 is formed between a central portion of the guide 16 and the guide leg 36. The guide leg further includes a connection element 38 in the form of a protruding bump or other radially extending formation

that is positioned at or about the linear extent of the guide leg 36. The gap 42 permits a radially extending connection element to be moved (typically temporarily) in an inward radial direction as the guide 16 (whether taken alone or as part of a subassembly with a valve) is positioned within a segment of the body 12. With such a configuration, as shown, the connection element 40 will eventually move or snap into position within a receiving portion 40. Thereafter, an interference formed between a portion of the connection element 38 and the receiving portion 40 of the body 12 will generally prohibit undesired linear movement of the valve guide 16 along the direction of flow path, particularly in direction moving away from the fluid entry portion 20.

[0026] The present invention is not limited to the connection between the valve guide 16 and the body 12 as described above. For instance, the connection element 38 of the guide 16 may take the form of a female connection component (such as a recess), and the receiving portion 40 of the body 12 may correspondingly take the form of a protruding formation that extends radially inward into the body opening to engage the connection element of the guide. Further, the body 12 may include additional engagement means, such as a pin, threads, or a nut, which may be separate or integral with the components, to retain the valve 16 at a desired position. Additionally, if desired for certain applications, the assembly 10 may further include additional components, such as, without limitation, a split ring, a ring, threading, an external nut (e.g., a B-nut identified as 48) or a wire (such as industry standard-type wires 50).

[0027] As previously noted, the invention permits all of the internal components of the valve and associated guide to be inserted into place via an outlet port opening and to substantially lock into a stable engagement with the body 12. One embodiment of such a method for manufacturing a valve assembly involves the following steps (which are not necessarily in order): (a) providing a body 12 that includes a central longitudinal axis **L**, a shaped cavity, a fluid entry portion 20, and a fluid outlet portion 22; (b) providing a valve 14 having a shaped valve head 26 that includes an exterior surface portion 30 that is configured to engage a portion of the shaped cavity 24; (c) providing a guide 16 including a central axis **CA**, a central opening 32 for receiving at least a portion of the elongated portion of the valve 28, and a plurality of radially disposed formations that connect the guide to the body; (d) providing a biasing mechanism (e.g., a spring 34) that biases (and may selectively bias) the valve in the direction of the shaped cavity; (e) assembling the guide 16, the biasing mechanism, and the valve 14 so that the biasing mechanism is disposed between a portion of the guide 16 and valve 14; (f) inserting

the guide 16, the biasing mechanism, and the valve 14 into the body through the fluid outlet opening 22; and (g) connecting the guide 16 to the body 12. Upon connection, the guide 16 should be substantially retained relative to the body 12 and the central axis **CA** of the guide 16 should be substantially in alignment with the central longitudinal axis **L** of the body 12 such that a sufficient surface to surface seal can be made between a portion of the shaped surface 30 of the valve head 26 and an engaged portion 24 of the shaped cavity when the assembly is in a "closed" configuration.

[0028] In an embodiment of the method, one or more of the radially disposed formations include front and rear centering formations and may include a guide leg 36 (which may or may not include a connection element 38 as previously discussed) that is radially spaced from the rest of the body of the formation. With such a method, the centering formations 39a, 39b are used to position the guide within a desired configuration within the body. When present, the guide leg 36 can be used to assist with both the orientation and the retention of the guide 16 within the body 12 of the assembly 10. Further the connection may also entail the inclusion and engagement of additional connection devices, which may include, without limitation, wires, rings, split rings, nuts, pins, etc. Such additional connection devices can be used for, among other things, to provide further retention of the aforementioned components within the assembly.

[0029] In one embodiment of the method, the guide leg includes one or more guide legs with connection elements and the body includes one or more corresponding grooves or recesses for receiving a portion of the guide leg. Moreover, if desired, the guide leg may be tapered or cantilevered radially outwardly. When the guide is properly oriented and inserted into the body, the connection elements of the guide leg may "snap into" (radially outwardly) or otherwise engage the corresponding grooves or recesses and the guide will be appropriately oriented and retained within the body.

[0030] The foregoing method of assembly can commonly simplify the manufacturing process. Moreover, the invention can also, among other things, reduce the associated manufacturing/assembly costs; reduce the weight of the assembly; eliminate the need for radial retaining rings, or the need to swage or thread the valve assembly into place; and can provide reduced weight.

[0031] While the present invention has been particularly shown and described with reference to the foregoing preferred and alternative embodiments, it should be understood by those skilled in the art that various alternatives to the embodiments of the invention described herein may be employed in practicing the invention without departing from the spirit and scope of the invention as defined in the following claims. It is intended that the following claims define the scope of the invention and that the method and apparatus within the scope of these claims and their equivalents be covered thereby. This description of the invention should be understood to include all novel and non-obvious combinations of elements described herein, and claims may be presented in this or a later application to any novel and non-obvious combination of these elements. The foregoing embodiments are illustrative, and no single feature or element is essential to all possible combinations that may be claimed in this or a later application. Where the claims recite "a" or "a first" element of the equivalent thereof, such claims should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more such elements.